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FOR NASA

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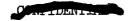
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROJECT GEMINI

STATUS REPORT NO. 3

FOR

PERIOD ENDING NOVEMBER 30, 1962

By Manned Spacecraft Center

INTRODUCTION

This status report is the third in a series of reports on the second NASA manned-spacecraft project, Project GEMINI. The second status report covered the progress made through August 31, 1962.

During this reporting period, two boilerplate spacecraft were completed and delivered to vendors for ejection seat and parachute drop tests. These two boilerplates plus two others which were completed during the second reporting period made a total of four boiler-plates which underwent testing between September 1, and November 31, 1962.

The most significant area of activity during this reporting period was a reevaluation of the entire GEMINI program owing to funding limitations. The lack of funds necessitated the cancellation of some activities and several shifts in emphasis. No major design changes were made during this period. Wind tunnel, parachute and paraglider test programs reached partial completion; a half-scale paraglider was flown successfully but was slightly damaged while landing, and a half-scale spacecraft was successfully dropped and recovered in the fourth emergency parachute test.

Formal training of the flight crew personnel was initiated. The pilots received a GEMINI familiarization course and are attending basic science lectures. Their activity will also include development and training work with spacecraft and similators now under construction.





MANUFACTURING

PRODUCTION

Boilerplate No. 1 was delivered to Northrop-Ventura for use in parachute and paraglider test programs.

Boilerplate No. 2's schedule has been revised because of the delayed delivery of the Environmental Control System (ECS). It is planned to install the ECS into Boilerplate No. 2 while still in the Project GEMINI manufacturing area and to supply the fully-assembled test vehicle to the McDonnell Aircraft Corporation test laboratory about March 15, 1963.

Boilerplate No. 3A has been shipped to Weber Aircraft Corporation for use in ejection seat testing.

Boilerplate No. 4's design by Weber is 85 percent complete and the fabrication of hardware and structure is underway. It is scheduled for delivery to McDonnell Aircraft Corporation on January 31, 1963, where it will be used in skid-landing tests.

Boilerplate No. 5 was delivered to Northrop-Ventura for parachute qualification drop tests.

Figure 1 shows the spacecraft delivery and launch schedule as of the end of this reporting period.

Other hardware. - All five boilerplate rendezvous and recovery sections have been completed and shipped to Northrop-Ventura.

The main frame structure has been completed for Static Article Nos. 1, 2, 3, and 4 and Spacecraft No. 1. Main frame welding for Spacecraft No. 2 is also nearing completion.

The pressure vessel for the Compatibility Test Unit Vehicle is approximately 85 percent complete.

The Electronic Systems Test Unit vehicle has been fabricated, installation of the wiring is approximately 75 percent complete, and equipment installation has begun.

Two Reaction Control System (RCS) structure sections have been completed and shipped to Rocketdyne for use in RCS testing.





The tooling has been completed for the sills, main frame, side panels, small pressure bulkhead, cabin structure assembly, and the pressure vessel weld assembly. The majority of the tooling remaining to be completed is for the reentry RCS section and the adapter quarter panels. A few assembly fixtures and dollies are also incomplete.

MOCK-UP

Revisions to the engineering mock-up resulting from the formal review in August were inspected by the MSC on November 15 and 16, 1962. The final review is scheduled for mid-December 1962.

MAJOR SPACECRAFT SYSTEMS

The status of the spacecraft systems plus the problem areas associated with it are discussed in the following subsections.

CONFIGURATION AND WEIGHT

Configuration

There have been no major changes to the Project GEMINI spacecraft configuration during this reporting period. As a result of the mock-up review in August, a few minor changes were made. These changes are covered in the following paragraphs:

A hoisting loop for use during recovery operations will be installed at the top-center line forward of the spacecraft heat shield. The loop will be stowed under a protective door which will be jettisoned by the crew upon landing. The loop will automatically spring into the deployed position when the door is jettisoned.

The horizon scanners were repositioned to approximately Z station 166.0 where the conical and cylindrical sections meet. Wind tunnel tests are being performed to check the new scanner fairing.

It was decided to braze all fuel lines and oxidizer lines in both the Orbit Attitude Maneuvering System and Reaction Control System propulsion units. This should reduce the chance of leakage in these critical systems.

During this reporting period, periodic reviews of the mock-up were held. They included inspection of Request for Alterations (RFA) changes and also a cockpit study conducted by flight crew personnel. A number of changes to the crew compartment resulted from these reviews. Changes included ejection seat improvement, relocation of controls and rearrangement of displays.

The rendezvous and docking displays have been moved to the docking adapter itself. They were previously planned for installation in the GEMINI spacecraft instrument panel.



Weight

Only minor changes have been recorded in total spacecraft weights during this period. The rendezvous-mission configuration decreased 27 pounds to 7,188 pounds and the 14-day mission configuration increased 44 pounds to 6,986 pounds. The percentage of calculated and actual component weights as opposed to the estimated weights contained in the total weight figures is growing rapidly. It is encouraging that the total weight has not increased appreciably as the values become more firm.

STRUCTURE

Tests

The major efforts during this reporting period have been directed toward detailed definition of structural loading tests and continued study and refinement of configuration, structure, and equipment installation details.

Two static article spacecraft, a rendezvous and recovery section, a RCS section, and various special test specimens will be used for the structural static test program.

Static Article No. 3 will be tested for the aerodynamic loads of launch and reentry, and the parachute deployment and landing loads. It will also be subjected to thermal tests using heat values equal to the critical heating of reentry. Static Article No. 1 will be tested for the loads of the paraglider, ejection seat, hatch, and cabin pressurization. A rendezvous and recovery section will be tested for the integrity of the drogue parachute mortar support, rendezvous radar support, and nose fairing, while a RCS section will be subjected to the launch spacecraft hoisting loads. A single beryllium shingle will be tested for the docking impact loads.

The above tests have been defined by McDonnell Aircraft Corporation. These tests and others associated with the adapter and special structural details will be reviewed the week of December 3, 1962, to establish a firm detailed program.

Design

Design work is continuing for the recently relocated horizon scanner installation, the recovery loop, the adapter modules with their integral retrorocket blast shielding, the GEMINI spacecraft and target



vehicle docking structure, and the seat change for the 24G catapult. The existing design in all other areas is continually being refined as more precise loads information is obtained.

A thirteen pound weight reduction of each hatch was accomplished by redesigning the hatch for the reduced loads as determined from the wind tunnel tests, plus employing more extensive chemical milling and making a more optimum selection of materials.

Docking Equipment

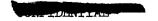
The docking equipment and structural configuration is almost completely defined in concept, and some drawings have been released. Specifications for the mooring system, the latch release actuator, and the general structural arrangement of the docking adapter are established. Docking impact tests are planned on both a corrugated and a semi-monocoque cone structure to determine which is best suited for the function. Study is also being given to obtaining a cleaner reentry configuration of the GEMINI spacecraft docking receptacles, although the present design uses a sliding door (recessed a quarter-inch) to cover the receptacles. Six-degrees-of-freedom computer studies are being made of the docking damper characteristics, and a test using a quarter-scale docking dynamic model is due to start during December 1962.

Ejection Seat

The rocket sustainer thrust pad of the ejection seat has been redesigned to withstand the loads of the new 24G rocket catapult. A static test of these loads will be made about December 18, 1962. The thrust pad and its backup structure must withstand the impact load that occurs when the sustainer rocket is stripped from the catapult tube and also when the rocket moves approximately three-eights of an inch to seat on the thrust pad. If the thrust pad deforms under the impact, it allows the rocket barrel to shift slightly and misdirect the thrust vector from the seat-man center of gravity, thereby resulting in a degradation of the trajectory.

Horizon Scanner Relocation

The horizon scanners were moved from the equipment compartment area near the heat shield to the left side of the conical section's small end, just aft of the RCS section. The structure is made rigid by a one-piece machined fitting which is spliced into the stringer-former cone structure. This fitting incorporates the electrical disconnects and pyrotechnic ejector attachment and is covered with an ablative heat-protecting structure. The scanners mount on a rigid plate which is torqued to the structural fitting at the ejector attachment and bears



out on the ablative structure. Provisions are incorporated in the scanner mount plate for alining the scanners with the stable table of the Inertial Guidance System. A fiber glass fairing covers the scanner installation. A pyrotechnic ejector for jettisoning the cover is also enclosed within the cover.

Recovery Loop

The recovery loop was moved from the nose gear to the top of the large pressure bulkhead, above and behind the pilots' heads. This change will allow the spacecraft to be recovered in a horizontal attitude. The loop is stowed under a jettisonable door which is deployed by the crew after landing. The installation is designed for the 3G's anticipated from a rolling ship during recovery operations, with the loop suspended from a nylon line. However, the loop may also be used in recovering the spacecraft after making a hard landing.

During the next quarter, all of the structural design should be completed and the static test program should be well under way.

HEAT SHIELD

During this reporting period, increased confidence in the McDonnell Aircraft Corporation-developed heat shield caused the back-up heat shield program to be canceled. The back-up heat shield was never intended to be of an advanced design, but represented a proven design based on Project MERCURY experience. Its cancellation will result in a cost savings in excess of \$100,000.

Tests

The Project MERCURY MA-8 mission carried samples of the Project GEMINI heat shield material as part of an experiment. The results of the experiment indicated acceptable performance at this low heat flux level. However, in an effort to improve the material performance, the honeycomb will be dipped in a heat resistant binder prior to filling it with the ablation material. Testing to validate this change will be conducted at Langley Research Center and McDonnell Aircraft Corporation in the near future. Although the heat shield data is preliminary, other tests at Langley Research Center, Plasmadyne and General Electric continue to verify the good thermal characteristics of the material.





Delivery

Tool checkout is virtually complete, and it now appears that the first prototype heat shield will be available about January 20, 1963.

SOLID PROPELLANT ROCKET SYSTEMS

As discussed in earlier progress reports, the four solid propellant rockets serve two purposes: (1) to provide retrograde impulse to reenter the atmosphere from orbit, and (2) to abort the spacecraft above 70,000 ft.

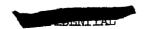
Design

During this reporting period no major changes have been made to the retro-rocket design, and design performance has remained at 2500 pounds thrust with 13,800 pounds-sec total impulse. A change from two squibs to one pressure cartridge per-pyrogen has been incorporated into the motor initator. The pressure cartridge will increase rocket reliability and permit a reduction in total loaded motor weight. A rubber nozzle closure will be used in place of the metal closure in order to prevent damage to the blast shield. A new graphite throat insert has been selected to decrease nozzle erosion.

The engine design is complete. Procurement of the major engine components has been initiated and vendors have been selected. Owing to a decrease in funds for Fiscal Year 1963, only the developmental tests, 80% of the total Aerospace Ground Equipment (AGE) effort in this program, and six preproduction (developed) motors for the first spacecraft are scheduled for completion during this fiscal year.

Testing

One of the anticipated problems associated with the polysulfide propellant in the rocket motors is providing a proper cure technique when the propellant is placed in a spherical case. A number of tests have been conducted in which various techniques of curing small samples of propellant were evaluated. Tests show that an inert nitrogen atmosphere with controlled humidity is the best solution. Two TE-345 cases were loaded with the polysulfide propellant which will be used in the Project GEMINI rocket engine. These TE-345's will be used to evaluate the grain-cure technique in a motor closely resembling the TE-385. Other objectives of the evaluation included propellant characterization and ignition delay determination. The cure technique proved to be satisfactory. However, static firings of the two engines





indicated that the TE-385 probably will not meet the specification ignition times. Therefore, the pyrogen is being redesigned. Three additional TE-345 tests are planned to evaluate the redesigned initiator. Additional propellant characterization information is being obtained from tests in the blast shield program.

Pressure Cartridges

Holex has been selected as vendor for the pressure cartridges of the retro-rocket engines and the cartridge design has been completed. At the present time, no difficulties are anticipated in attaining the minimum no-fire requirements established by Cape Canaveral Range Safety.

Alinement Procedure

Considerable effort has been expended in developing a reliable, accurate, and simple method for alining the rocket motors in the adapter section. This resultant alinement method will minimize weight by permitting complete removal of all alinement devices after the completion of motor installation in the spacecraft. The technique will also permit the removal of any retro-rocket motor and reinstallation of the same or a different motor without demating the reentry section from the adapter. The design effort on other major AGE items has been progressing rapidly and is almost complete.

BLAST SHIELD

As discussed in the previous progress report, the blast shield program was initiated to prevent hypergolic propellant and cryogen explosions in the equipment portion of the adapter as a result of firing the retro-rockets. The blast shield test program has been separated into three series:

- Series I. Materials evaluation.
- Series II. Preliminary shield design evaluation through simulated separation tests.
- Series III. Full scale simulated altitude abort tests.

Tests

Series I tests have been completed and Series II tests have been initiated. In Series II, tests one through four resulted in specimen failures which indicate that more protection will be required than





determined from the Series I tests. Results of the following two Series II tests showed that the required protection will need to be twice as much as originally anticipated. In the last two Series II tests, a change in the type of fiber glass cloth as well as the performance of a seal and an equipment fastener were evaluated. A technical report on Series I and II tests has been initiated by the prime contractor. Series III tests will be conducted using a full-scale adapter in the abort mode at a simulated altitude of 20,000 feet under simulated flight conditions. Preliminary test planning has been initiated and a test cell has been selected by Arnold Engineering Development Center (AEDC).

PYROTECHNICS

Development and Testing

Development of the flexible linear-shaped charge separation assemblies has been completed and qualification testing has begun. More than 100 developmental test firings of the hatch actuator, using simulated hatches, were performed. Firings to determine the dynamic response of the flight model hatches were initiated. Qualification testing of the mild detonating fuse initiation system for the hatch actuator has also commenced.

Requirements for the "y" gun nose-fairing release assembly were canceled. Instead, this function will be actuated upon guillotine cutting of a cable which permits the release of the fairing by a compressed spring.

Approximately 40 developmental firings of the Z100.75 separation assembly were performed to determine proper core loading and assembly. This assembly will be used to sever wire bundles, tubes and straps at the adapter-reentry section interface. Developmental work was completed and qualification testing was initiated on the mild detonating fuse for the rendezvous and recovery section ring-separation assembly.

Development of a wire bundle guillotine and a tubing-cutter sealer is 75% complete. The hydraulic hammer effect of the sealers is being investigated. The sealing function appeared to be satisfactory. Drawings were received and manufacturing is now complying with the latest changes of the landing gear devices specification.

Procurement

Bids from four vendors on the emergency docking release system were evaluated. Specifications of the horizon scanner release assembly and



horizon scanner fairing release assembly were revised to conform with the location and design changes. Proposals from six vendors on the emergency docking bar assembly were also received. Ordnance Associates was selected to develop the pyrotechnic switches and the mild detonating fuse for the landing gear door-jettison system.

Cost Evaluation

As part of the overall project cost reduction, pyrotechnic system tests were reduced from ten to six. A review of the pyrotechnic initiation circuits was also conducted. Except for the separation assemblies and retrorockets, all quadruple redundancy was reduced to double redundancy. An estimated system weight savings of 15 pounds was achieved through these circuitry changes. Pyrotechnic hardware design was kept unchanged since estimated weight savings were judged to be too small to justify a redesign.

LANDING SYSTEMS

Paraglider

The final predeployed flight test of the half-scale paraglider was conducted at Edwards AFB, California, on October 23, 1962. Verification of the test vehicle's stability, maneuverability, and performance during glide, preflare, and flared landing was accomplished satisfactorily. The vehicle was released from an H-37B tow aircraft at an altitude of 8500 feet by radio command from an T-37 director aircraft. Sixteen maneuver commands were given by the T-37 and six commands, including preflare and flare, were given by a ground control van during the flight which lasted 264.4 seconds. Good response to all radio command functions was indicated. Immediately after touchdown, the forward skid crush structure dug into the lake bed and caused the vehicle to tumble. Damage to the test vehicle and paraglider was minimal.

The next flight of the half-scale vehicle will be a deployment flight scheduled for early December. The vehicle is to be dropped from an H-37B at an altitude of 12,000 feet and will go through a complete deployment and inflation sequence and a controlled flight sequence similar to that effected during the predeployed tests. Seven tests are scheduled for this series, during which deployment loads and aerodynamic parameters are to be measured by on-board recording systems.

Paraglider interface meetings. - North American Aviation submitted a preliminary draft of the "GEMINI Paraglider Design Criteria Specification". This document defines the structural design criteria

COMETTENANTAL

for the GEMINI paraglider wing and shall serve as the prime reference for design principles, environments, and crew requirements for all North American Aviation personnel participating in the design, analysis, and fabrication of the GEMINI paraglider wing.

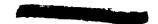
CONTRACTOR

A list of spares and AGE for support of the spacecraft (Static Article No. 2) to be provided to North American Aviation for paraglider qualification and testing was submitted by McDonnell Aircraft Corporation for NASA — MSC-GEMINI Project Office approval. The GEMINI Project Office reviewed the requirements and directed McDonnell Aircraft Corporation to deliver the approved spares and AGE with the static article spacecraft.

The philosophy for incorporation of the North American Aviation paraglider control system drawings into the McDonnell Aircraft Corporation drawing system was established by the GEMINI Project Office. North American Aviation will provide-McDonnell Aircraft Corporation with production assembly and installation drawing numbers and titles for paraglider components. McDonnell Aircraft Corporation will call out these assemblies and installations on their Paraglider System Installation Drawing.

The following criteria were agreed upon in the Interface Meetings:

- (1) The location, mounting and access requirements of the paraglider electronics packages
- (2) The dynamic pressure, Mach number and flight path angle for reentry from a 150 nautical mile orbit with a paraglider deployment altitude of 50,000 feet
- (3) The d-c power requirements for the paraglider inflation and control system
- (4) The paraglider system weight and balance breakdown based on a system weight of 510 pounds
- (5) The preliminary electrical system diagram for Static Article No. 2 spacecraft
- (6) The preliminary time-temperature histories for the paraglider component areas
- (7) The preliminary operational and functional test requirements of the paraglider system



North American Aviation stated at the Interface Meeting of October 9 and 10, 1962, that the make-up bottle and associated components and circuitry could be eliminated from the paraglider inflation system. This will aid in simplifying the inflation system.

Emergency Parachute Recovery System

The Emergency Recovery Parachute System will provide a means of recovering the boilerplate spacecraft in case of paraglider failure during the paraglider test program.

Emergency recovery system.— The fourth drop-test of the half-scale vehicle emergency parachute recovery system was conducted over the Edwards AFB Bombing Range on September 4, 1962. The vehicle was recovered satisfactorily and the main objective of the flight, deployment at a low dynamic pressure, was accomplished.

The third full-scale vehicle drop-test of the emergency parachute system was made over the El Centro Naval Auxiliary Landing Field Range on September 7, 1962. The test vehicle was recovered with minor skin damage and no internal systems damage, although two of the three parachutes failed as a result of premature disreefing. Following this test, the contractor was directed to incorporate the latest Project MERCURY reefing installation on the parachutes.

The fourth full-scale vehicle emergency recovery test was conducted over the Edwards AFB Bombing Range on November 15, 1962. Following deployment of the parachutes, the bridle for the main riser line broke at both the forward and above the aft attachment point to the test vehicle. The resulting impact damaged the spacecraft beyond economical repair. Because of the loss of the test vehicle and internal components, it does not appear economically feasible to conduct another test to prove out the recovery system which, functionally, has demonstrated satisfactory operation. Accordingly, this portion of the program is considered completed following suitable strengthening of the riser bridle.

Parachute Recovery System

During this reporting period, nine parachute drops were completed using the 84-foot recovery parachute being developed for the GEMINI spacecraft by Northrop-Ventura. Of the nine drops completed, test objectives were successfully met on five drops, partially met on one drop and were not met on three drops. From the five successful drops, the following parameters have been determined:

(1) The optimum reefing ratio for the 84-foot parachutes



- (2) The reefed and disreefed loads associated with the optimum reefing ratio
 - (3) The rates of descent for the parachute
- (4) The structural integrity of the parachute at the design deployment dynamic pressure.

Some minor problems with the parachute remain to be solved, but the solution to these problems should not affect the already established reefing parameters. Between seven and ten drops remain in the present phase of the parachute drop program before proceeding to the second phase involving GEMINI boilerplate spacecraft no. 1 and no. 5. The seven-ten drops should be completed by mid-January 1963.

ENVIRONMENTAL CONTROL SYSTEM

Development of the Environmental Control System (ECS) components is continuing. System developmental tests are scheduled to start during the next reporting period. Delivery of the first production prototype ECS unit to McDonnell Aircraft Corporation was slipped two months and the delivery is now scheduled for January 1963.

A utilization plan for food and waste management has been formulated. Development of food, food storage compartments, and waste handling equipment is continuing. Proposals for sanitation equipment are due to be received early in December.

CO₂ Partial Pressure Sensor

The design of the CO₂ partial pressure sensor has been completed by the Lion Research Corporation. The finalized design reflects several changes from the original concept. The sensor and amplifier have been integrated into one package and the ionizing voltage has been changed from d-c to low frequency a-c. These changes will simplify installation of the sensor and increase the reliability of the system. The scheduled delivery date of the first engineering prototypes has slipped from September 1962 to January 1963 due to delays in awarding a contract to Lion Research Corporation. The design of AGE equipment to support the ECS has been completed by McDonnell Aircraft Corporation and delivery is scheduled for January 1963.

PRESSURE SUTTS

The B. F. Goodrich Company has been selected as vendor for the Project GEMINI prototype pressure suits. The second prototype suit has been received and is being evaluated. Additional prototype suits are scheduled for delivery in January 1963 for use in ECS testing, sled tests and general test work.

ASTRONAUT INSTRUMENTATION

Proposals for the signal conditioners of the Biomedical Instrumentation System have been evaluated by representatives of the Crew Systems Division, GEMINI Project Office, and Systems Evaluation and Development Division of the MSC. A vendor has been selected for each of the signal conditioners. Award of these contracts has slipped about four months, but delivery dates of flight hardware are expected to be compatible with spacecraft requirements.

The Cook Electric Corporation has been awarded a contract to build the biomedical tape recorder which will supplement the spacecraft data system. Delivery of the first prototypes is scheduled in February 1963.

LIQUID PROPELLANT ROCKET SYSTEMS

The Orbit Attitude and Maneuver System (OAMS) and the reentry Reaction Control System (RCS) comprise the liquid propellant rocket systems aboard the GEMINI spacecraft. Changes to these systems during this period are discussed below.

Design Modifications

Performance of the two OAMS decelerate engines has been decreased to 85 lbs, but the schematic remains unchanged. McDonnell Aircraft Corporation has concluded demonstration studies of the feasibility of an all-welded system. Based on the conclusions of these studies the OAMS and RCS will be an all-brazed system which will result in a reduction of leak paths and a decrease in total system weight.

A system has been selected for propellant quantity gaging. This system consists of a direct readout in pounds of propellant based on the pressure and temperature of the source pressurant. There will also be a provision for computing the effects on propellant quantity indications resulting from variations in the nominal temperature and pressure of the



system downstream of the pressurant supply. This system will be simple and economical to install in the spacecraft and will have an accuracy of ±2.6 pounds (one sigma).

Schedule

Design of the OAMS and RCS is fixed. Drawings have been released and drawing revisions to accommodate brazed fittings are 50% complete. Promised shipping dates of components from the vendors show compatibility with the delivery schedule. It is anticipated that system delivery to McDonnell Aircraft Corporation will be on schedule although the vendor is behind schedule in testing.

Testing

Developmental testing of system components is approximately three weeks behind schedule, while system developmental testing is approximately five weeks behind.

System tests of the OAMS have been initiated and RCS tests continue. Over thirty hot firing tests of the OAMS and RCS have been made. These system tests have pointed out problems with regard to oscillations of the propellant in the fuel system. Possible solutions to the line oscillation problem are now under consideration.

Tests have also been conducted on all thruster control component packages or their individual components, as in the case of component package B. Emphasis has been placed on components of all packages rather than the assembled package.

The titanium tanks test program has been completed and tests have been initiated to establish fill procedures for these tanks.

Special Projects

In addition, Rocketdyne has been conducting tests for several special projects:

- (1) Tests were conducted to develop a procedure for decontaminating the RCS. The final report of these tests was completed.
- (2) Vacuum and heat soak tests have begun on the 25-pound thrust chamber assembly to determine if outgassing will present any special problems; preliminary test analysis indicates that no problem exists.
- (3) Martin Company's blast-duct tests will be conducted to determine the design adequacy in the environment of the 100-pound thrust chamber exhaust. These tests are scheduled to begin the middle of December.



(4) Numerous materials have been subjected to propellant compatibility tests and tests are still continuing to select the types of material for various components in the systems.

25-Pound Engine Development

The primary problem area of the liquid propellant rocket systems is the development of a 25-pound thrust engine which will perform within specification over a burn time of five minutes. An extensive research effort has been exerted in developing this engine. Three-minute chambers for the RCS have been successfully tested, thus permitting system delivery for the first spacecraft. Research and development continues on the five-minute chamber which will be used for attitude control in orbit.

Bladder studies and evaluation programs have shown that TFE-FEP Teflon is the most satisfactory bladder material. Fabrication techniques and product consistency comprise the primary problem areas for this component.

Subcontracts

The pressure regulator will be produced by National Waterlift since the cancellation of the Sterer design. Hardware is now being produced by Waterlift.

The motor operated shutoff valve will also be built by National Waterlift. A heavyweight design has been received by Rocketdyne from National Waterlift and is currently under evaluation.

Vendors have been selected for the pyrotechnic devices associated with RCS and OAMS, and developmental units have been sent to Rocketdyne for preliminary evaluation.

Aerospace Ground Equipment

Vendor design of the AGE is 90% complete. Some interim units have been delivered to McDonnell Aircraft Corporation. AGE delivery is on schedule according to the latest overall program requirements.



EJECTION SEAT SYSTEM

Tests

Pad ejection test. - On September 12, 1962, simulated off-the-pad ejection test no. 6 was conducted at the U.S. Naval Ordnance Test Station, China Lake, California. In this test a non-instrumented Alderson dummy was used. Seat/dummy separation was effected and both the dummy and the seat were recovered.

Simulated off-the-pad ejection test no. 7, a dual firing, was conducted at the China Lake facility on September 26, 1962. Instrumented Sierra dummies were used in this test. It was concluded that both ejection seat-systems would have provided satisfactory emergency escape under the conditions tested.

However, there were some problems revealed by these tests. The seat used in test no. 6 pitched head down during the latter portion of rocket burning. This condition also occurred on one of the seats used in test no. 7. The other seat used in test no. 7 rolled to the right. Post-test inspection indicated that the seat structure thrust-pad area had yielded in test no. 6 and failed on the seats used in test no. 7.

Based on results of these tests, the mounting structure for the thrust pad was reanalyzed and redesigned. Simulated off-the-pad testing was temporarily halted until the final configuration rocket catapult becomes available.

Sled ejection tests. - On November 9, 1962, the drag run for the sled ejection tests was conducted at the Naval Ordnance Test Station, China Iake, California. The test objectives were to determine the aerodynamic drag and to prove the structural integrity of the vehicle. The majority of the test objectives were met in that the aerodynamic drag was obtained and the test vehicle proved to be structurally sound. However, a structural failure in the booster (pusher) vehicle permitted a solid propellant motor to accelerate forward and penetrate the heat shield of the boilerplate spacecraft mounted on the test vehicle. The resultant fire severely damaged the interior of the spacecraft and destroyed a considerable amount of instrumentation and equipment. However, the vehicles did remain on the track and completed the run.

The boilerplate spacecraft is currently being repaired. Major modifications or rebuilding of the booster vehicle will be required and this work has been initiated. However, this work will cause no foreseeable delay in the sled test program.



GUIDANCE AND CONTROL SYSTEM

Attitude and Control Maneuver Electronics

Two engineering prototype Attitude Control and Maneuver Electronics (ACME) Systems were delivered to McDonnell Aircraft Corporation in October along with an ACME Interim AGE tester. One of these units was installed in the Electronic System Test Unit and subsystem compatibility checks were conducted using the prototype horizon scanners.

Assembly of a production welded module and relay cards is progressing rapidly and final harness wiring has been started.

Vibration testing of the critical components, namely, Babcock relays and a WX118XC Westinghouse power transistor was completed. The relays were subjected to vibration levels of greater than 50 G's and the power transistor underwent approximately 175 G's with no electrical failure or malfunction detected.

Vacuum tests were conducted on the Attitude Control Electronic module boards to ascertain thermal design characteristics. The case temperature of the output power transistors, which is the highest heat source, and other preselected components were monitored while the board was in electrical operation. Data showed that the transistor case temperature is only 45°F. higher than the cold plate temperature, so it is reasonable to conclude that the Attitude Control Electronic module boards design will encounter no thermal problems.

A qualification and reliability test review was held and a final acceptable test program was adopted.

Inertial guidance system computer. The 8 mc clock oscillator for computer no. 4 and later computers was life-tested at an elevated temperature to determine drift characteristics. An accumulated 500-hour test showed that the oscillator parameters remained well within design limits. Additional laboratory tests were made to verify load requirements of the oscillator and clock drivers.

All a-c interface circuit design and test specifications have been released.

Additional tests were performed on the magnetic modulator of the digital-to-analog converter to determine gain and phase errors as a function of widely varying load conditions. A buffer amplifier is designed to provide a constant load to the magnetic modulator. This load will be relatively independent of the buffer amplifier load.



Several delay lines currently being tested show that the signal-to-noise specifications under worse-pattern conditions are not being met by all lines. However, the more recently received lines have achieved much better ratios than the lines received earlier. The lines received have not shown any other electrical problems.

The basic design effort for the engineering prototype computer is almost complete. The production computer detail and sub-assembly drawings for the memory array, cross-over detector, sequencing relays and power regulator have been released. The design and artwork for the multilayer printed circuit harness boards nos. 1, 2 and 3 has been completed. The design layout for memory harness boards nos. 4 and 5 is also complete. Each harness board will be 0.166-inch thick and will be composed of 15 conductive layers.

A live production memory plane mounted in the memory array was subjected to shock and vibration tests. After testing, this plane was checked out functionally and found to have outputs identical to those recorded before testing.

A preliminary d-c power loading analysis was made for the computer. The computer peak-power consumption occurred during a store operation. Peak computer current is 6.599 amps., with an average of 5.035 amps. This includes a minor amount of current supplied to the incremental velocity indicator and the manual data insertion unit.

A review of the Qualification and Reliability Test Plan for the computer was held and the NASA overstress and life testing plan was adopted.

Inertial measuring unit. - Assembly of the first engineering model platform is almost complete although it was delayed by vendor delivery problems on the synchro phase-shifters. The unit should be complete by December 15, 1962.

A procedure to analytically determine the thermal radiation between the spacecraft skin and the upper surface of the IMU equipment during re-entry was written and checked out for sixty different conditions. The procedure is a quick prediction device for determining the gross effects of radiation on the Inertial Measuring Unit during re-entry.

An analog simulation was performed and this simulation indicated that gyrocompassing and caging will each take approximately 17 minutes under extreme initial conditions (all three axes off 180 degrees). An analysis is underway to reduce the caging time under this condition to ten minutes by increasing the pitch torque amplifier gain by a factor of two.



A breadboard model was made of the new configuration International Business Machines cross-over detector circuit. Its performance is better than the first circuit, but it still does not meet the specification value rise-time of 15 nanoseconds (15 thousandths of a microsecond). The present cross-over detector circuit was also revised and its rise time has been reduced to 22 nanoseconds. However, the delay time in this circuit is more a function of the input voltage than it was previously, which may be a serious problem. Further improvement to the IBM circuit will be attempted.

A one-hundred hour run-in time for all platform gyros has been initiated. The allowable variation in gyro drift parameters during this cycling has not been finalized. By December 15, 1962, sufficient test data should be available to make a firm decision on the acceptable limits.

A review of the Qualification and Reliability Test Plan for the Inertial Measuring Unit was held and a final test program was agreed upon. It was decided to use an overstress-and life-test program in place of long-time reliability demonstration testing.

CREW STATION CONTROLS AND DISPLAYS

Modifications

The attitude hand controller has been redesigned to eliminate the pulse switch on the handles. The revised pulse mode uses a single 5 degree stick movement in the desired direction of attitude change to send a pulse to the thrusters.

Three lights have been incorporated in the control panel to indicate when the three landing skids are extended.

The Agena status lights were deleted from the control panel and remounted on the Agena adapter ring. This will enable the pilot to observe the readiness of the target vehicle through the spacecraft window just before docking.

An additional gage to indicate air pressure in the wing was added to the paraglider group on the instrument panel. This gage is necessary so that the pilot can determine the wing condition prior to execution of the flare maneuver. Potentiometers to control the paraglider servo system have been installed on the translation controller, thereby allowing the pilot to control the spacecraft descent using the translation controller. The translation controller has a T-bar configuration with





the pulse mode button installed in the end of the bar handle for control of the OAMS.

Studies

Cabin lighting studies are being conducted using the spacecraft mock-up. Preliminary results of these studies indicate that some method of individual light dimming other than the on-off control will be required. Series resistors and variable light filters will be evaluated as a means of dimming in the near future.

COMMUNICATIONS AND INSTRUMENTATION SYSTEM

Instrumentation System

Delivery of the instrumentation sensors will start on schedule in December 1962. McDonnell Aircraft Corporation's Electronics Engineering Division has delivered three breadboard and two engineering prototypes of the d-c and d-c converter, but there still remains the radio frequency interference problem of eliminating a glitch appearing on the output lines due to a 100-volt spike on the input lines. Engineering models of all the signal conditioning cards, except for a few d-c voltage monitor cards are on hand at McDonnell Aircraft Corporation. Assembly of the signal conditioning cards is delayed due to the unavailability of the enclosure package.

The Data Transmission System is being built and work is progressing according to recently modified schedules. A breadboard Pulse Code Modulation (PCM) system is scheduled for delivery to McDonnell Aircraft Corporation January 1, 1963 for Compatibility Instrumentation Mock-up tests. Deliveries of engineering prototypes are scheduled to start February 1, 1963. The Radio Corporation of America is scheduled to deliver the first two prototype transmitters to Electro-Mechanical Research Corporation on December 15, 1962. Qualification testing of a prototype tape recorder began November 15, 1962 at RCA and a prototype unit is scheduled to be shipped December 15, 1962 to McDonnell Aircraft Corporation for Compatibility Test Unit Mock-up tests.

The instrumentation system for Spacecraft No. 1 has been reviewed and McDonnell Aircraft Corporation is proceeding with procurement of voltage-controlled oscillators, mixers, amplifiers, and other equipment needed to carry out implementation. McDonnell Aircraft Corporation has instituted a procedure by which composite listings of all instrumentation parameters and pertinent data for each parameter are generated by an IBM computer. This procedure enables the updating of the parameters to be more readily accomplished.

Review of AGE equipment for the instrumentation system has been conducted with McDonnell Aircraft Corporation, NASA, and Electro-Mechanical Research Corporation. The PCM Telemetry Checkout Ground Station Specification has been completely defined and Electro-Mechanical Research Corporation is scheduled to deliver the first station to McDonnell Aircraft Corporation in January 1963. The spacecraft Data Transmission System Bench Test Set Specification is being revised and will be reviewed at Electro-Mechanical Research Corporation for concurrence on December 6, 1962 by them, McDonnell Aircraft Corporation, and NASA. The spacecraft Data Transmission System Simulator Specification



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is being written by the Flight Test Group of McDonnell Aircraft Corporation. It is being written along the guidelines presented at the NASA-Cape meeting on November 9, 1962, by Cape personnel of McDonnell Aircraft Corporation and NASA. The specification will be reviewed as soon as available.

Rendezvous Radar System

The first radar/transponder engineering prototype has been completed and is undergoing Westinghouse Electric Company operational-type acceptance tests prior to shipment to the McDonnell Aircraft Corporation December 22, 1962. The second engineering prototype will be completed approximately December 15, 1962, and will be used for mechanical tests at Westinghouse Electric Company. Pre-Installation Acceptance test equipment is near completion; one set will be retained at Westinghouse Electric Company for plant tests, and a second set will be shipped to McDonnell Aircraft Corporation December 22, 1962, with the first engineering prototype radar/transponder.

Modules are under construction for four production prototype radar/ transponders. Purchased items for this equipment are on schedule and some major components will be delivered soon.

Westinghouse Electric Company has received authorization to proceed with the design of radar/transponder modifications which will provide spacecraft-to-target command capability. However, Westinghouse Electric Company has not been authorized to proceed with the radar pod.

Radar Beacons

Production of the C- and S-band radar beacons is proceeding on schedule. An engineering prototype was delivered to McDonnell Aircraft Corporation on September 19, 1962. An engineering prototype C-band beacon has been operated at ACF Electronics Corporation under simulated reentry conditions with no degradation in beacon performance.

Recovery and Acquisition Aid Beacons

The design of the ultra-high frequency (UHF) recovery beacon is essentially complete. Difficulties in the design of the modulator and regulator have resulted in a 45-day slippage in the delivery of an engineering prototype beacon to McDonnell Aircraft Corporation. This prototype is currently scheduled for delivery on December 15, 1962. Delivery of the production units are compatible with spacecraft production requirements. The acquisition aid beacon, which is being built by the Vector Manufacturing Company, is proceeding on schedule.





Digital Command System

Engineering prototypes nos. 1 and 2 have been completed. Prototype no. 1 will be retained at Motorola Incorporated for in-house developmental tests, and no. 2 was delivered to McDonnell Aircraft Corporation for use on the Electronic Systems Test Unit. AGE interim test sets nos. 1 and 2 have been completed with one retained at Motorola Incorporated, and one delivered to McDonnell Aircraft Corporation. Motorola Incorporated still is operating under a letter of intent; however, negotiation of a contract is imminent.

Voice Communications

Engineering prototypes of the high frequency (HF) transmitterreceiver and the voice control center were received at McDonnell Aircraft Corporation. The UHF prototype is expected in a few days. A
switching transister failure occurred in the HF transmitter-receiver
power supply during preliminary tests. The unit was returned to Collins
Radio Company for a failure analysis. The automatic gain control characteristics of the GEMINI spacecraft receivers are being investigated
to determine whether it will be necessary to add a sidetone volume
control. The helmet headsets, microphones, cabin speaker, and hand
microphone concepts are still being investigated prior to establishing
the final system design.

Time Reference System

After completion of preliminary radio frequency interference tests, the engineering prototype of the time reference system has been installed in the Electronic Systems Test Unit. Reliability failure mode checks, failure effect analysis and stress analysis of the time reference system were completed. The design of all units was changed to include a timing signal output to the biomedical tape recorder and trigger timing pulses to the rendezvous radar. Interface design agreement was reached by all parties.

Antenna System

Engineering prototypes of all antennas have been reviewed and appear satisfactory. Radiation pattern tests were completed at McDonnell Aircraft Corporation for all antennas except the high-frequency voice antenna. An engineering prototype of the UHF reentry (nose stub) antenna was completed. The cover on the adapter UHF antennas, previously removed by pyrotechnics, is now held in place by a pin which is removed by a sequentially-operated solenoid. Engineering prototypes of the quadruplexer, diplexer, and coaxial switches were received by McDonnell Aircraft Corporation and preliminary tests results indicated satisfactory operation.





FUEL CELLS

Design and Manufacture

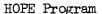
Manufacturing and assembly efforts on the cells and stacks were transferred to the "clean room." Structural, plumbing, and electrical facilities of the life, quality control, and reliability test areas were completed; however, only two of the development test stands were installed. A GE 312 computer was installed for production process control. Its use awaits completion of the testing facilities.

Designs for the fuel cell monitoring control unit, reactant supply subsystem, water transport system and structures was essentially completed. The reactant supply subsystem regulator will control the hydrogen pressure at 1.7 ± 0.5 psi above the water and the oxygen at 0.5 ± 0.18 psi above the hydrogen. Regulator flow capabilities will be 0.276 pph (pounds per hour) and 2.2 pph for the hydrogen and oxygen respectively. The water separators have satisfactorily passed vibration, acceleration, shock, and burst tests.

Tests

Tests using mice have shown the product water to be potable. Also, the ability of the stacks to operate normally with only one of the two cooling loops flowing heat transfer fluid (OS 139) was proven. A review of the General Electric qualification and reliability test programs has resulted in a realinement consistent with current funding and schedule requirements.

Experimental cells continue to exceed performance requirements, with attention now being directed towards the number of test failures. These failures are manifested as pinholes in the membranes and occur only during cell operation. These pinhole failures are in addition to the frame bonding and screen end puncturing previously reported. Examination of failed specimens has suggested causes such as sharp collector ribs, vacuum induced stress concentrations, leaking gasses, severe activation procedures and improper handling during the manufacturing process. A number of developmental changes have been initiated to alleviate the problems. These include: design improvements to reduce mechanically induced membrane stresses; use of a chemical instead of a mechanical bond preparation; correction of charging procedure; elimination of activation; thicker membranes; use of helium for leak detection; membrane humidity control; reduced pressure and temperature during assembly; improved screen handling; and closer quality control.



Investigations were conducted to determine the desirability of sponsoring a Project GEMINI oriented Hydrogen-Oxygen Primary Estraterrestrial (HOPE) program. The Air Force HOPE program which was intended to prove orbital functioning of a General Electric fuel cell under an extended zero G environment, was previously canceled. However, review of the Project GEMINI design indicated that: the probability of zero gravity inducing problems in the fuel cells is small; that the postulated problem could be removed by increased purging; and that proposed flight instrumentation could isolate such faults from others.

LAUNCH AND TARGET VEHICLES AND ASSOCIATED AGE

TITAN II

The first set of propellant tanks for GEMINI launch vehicle (GLV) no. 1 have been delivered to Martin/Baltimore. Reprograming the delivery schedule of the launch vehicles has been accomplished to coincide with revised spacecraft deliveries.

System Development

Spacecraft separation rocket discharge ducts. Firing tests are scheduled to begin on the discharge duct at Rocketdyne on December 15, 1962. This investigation will determine the suitability of the duct material to withstand a firing time of two seconds and the suitability of the interface seal between the launch vehicle ducts and the spacecraft rocket nozzles.

Launch vehicle component qualification program. Of the 89 components in the launch vehicle qualification test program, Martin/Baltimore has 40 components in their test program. Martin/Denver has the remaining 49 tested Titan I and Titan II components which will be used on the Project GEMINI launch vehicle. It is estimated that the qualification program will be 60 percent complete by the end of January 1963 and 100 percent complete by May 15, 1963.

Hydraulic system. - Extreme position switches have been added to the tandem actuators and they will make contact at the 4° engine nozzle position (engine nozzle hardover position). Electrical contact of these switches will automatically switch the tandem actuator and guidance system from primary to secondary system operation. Evaluation tests have started on the tandem actuator, with the null switch and transfer valve



components currently undergoing tests. Two hydraulic system selector valves are to be shipped on December 7, 1963 for use in the Airborne Functional Systems Test Stand tests.

Problem Areas

Longitudinal oscillation. All Titan II flights to date have experience a longitudinal oscillation during a portion of the Stage I trajectory. Analysis of the flight test data reveals that vibrational frequencies and amplitudes of significant physiological "G" values are present. A design change consisting of a standpipe in each leg of the Stage I oxidizer feed line was developed to effect a reduction in vibration amplitude.

Reliability

During this reporting period, the reliability status reporting program for the Project GEMINI launch vehicle was initiated by the manufacturing contractors. These contractors are stressing Quality Assurance by implementing a program wherein Quality Assurance personnel are reviewing procurement drawings for quality assurance provisions, reviewing both suppliers' and in-house test procedures, monitoring conformance to the standard in-house processes established for Project GEMINI and maintaining files on trouble reports, failure analyses and corrective action plans.

Abort Study and Malfunction Detection System

The fourth meeting of the Project GFMINI Abort Committee (launch vehicle) was held on November 13, 1962. Data were presented that established the necessity to sense the engine gimbal-angle to accomplish on-time switch-over to the secondary guidance system when necessary. Accordingly, it was decided to include gimbal angle as a switch-over parameter, using a value of four degrees as the switch-over point. All Titan flight data show that less than half of this value is the maximum that has been experienced. The maximum possible gimbal angle, including manufacturing tolerances, is five degrees. It was further determined that the sensor capability already existed in the actuators and that only wiring must be added. The analysis showing detection and ensuing

Editor's Note: This configuration was flight tested in December 1962 on the eighth Titan II flight. Preliminary analysis of the flight test data revealed the longitudinal oscillation was amplified by a factor of 2. Final assessment of this situation is dependent upon a detailed analysis now being conducted by the Martin Company.



motions are presented in Martin Report LV-118.

A requirement was placed on Martin to furnish analyses of all Titan II flights to date as to the influences on the Malfunction Detection System (MDS). The first two flight reports have been received.

The launch vehicle part of the integrated abort study has been published as Martin Report LV-97B. The spacecraft section will be available on or about February 1, 1963.

FLIGHT CONTROL SYSTEM

GEMINI launch vehicle stability. The study of the effect of tolerances on the GLV stability and control systems is scheduled to start in mid-December 1962 and the results will be reported in March 1963.

One additional pitch rate step has been added to the existing twostep TARS pitch program during Stage I flight to provide a more nearly zero lift trajectory.

Engineering drawings have been released for inclusion of a switching module and the Spin Motor Rotation Detection (SMRD) signal isolation amplifiers in the adapter package. The switching module is used to switch the Stage II actuators from the primary to the secondary autopilot system and the SMRD amplifier provides voltage amplification and a low output impedance to the AGE (Aerospace Ground Equipment).

A design change is now in work to add an input resistor in the attitude preamplifier-demodulator to enable a dynamic response test on the adapter-autopilot displacement channels. Tests have been completed on the investigation of:

- (1) Adapter-autopilot interface gain change.
- (2) The heat effect on the adapter-autopilot output due to unsynchronized 800-cps and 400-cps supplies.
- (3) The susceptibility of the autopilot to 800-cps and 400 cps noise.

An eight-hour low temperature qualification test has been successfully completed on one autopilot. This test is to be performed on a second unit and is scheduled to occur during the next reporting period.



Titan II thrust tailoff at sustainer engine cutoff (SECO) is being evaluated through examination of the telemetry tapes for the N-2 and N-4 flights. An analog stability study is also under way. The results of the analog study and the examination of the Titan II flight telemetry data will be correlated to determine how much of a problem tailoff will present to the Project GEMINI launch vehicle.

Radio Guidance System

Launch Guidance Equations. The Radio Guidance System guidance equations to be programed into the Burroughs Al computer were submitted by Aerospace. Equations for explicit yaw position steering were also added as an optional feature. The decision to include or exclude this optional feature on any given flight can be implemented by setting the proper value on a manual switch.

General Electric Mod III. An estimate of the Mod III injection errors including systematic and random errors have been submitted by Aerospace. A radar model error analysis has been requested from Aerospace including an investigation of the Mod III rate beacon.

MISTRAM. - Mistram data from three Titan II missile flights at the Atlantic Missile Range (AMR) and one B-57 ballistic camera test have been processed by General Electric. Pending additional processing and analysis of these data and more ballistic camera data which are currently being received from the Air Force Missile Test Center (AFMTC), a final evaluation report of Mistram flight tests will be distributed by General Electric in early February 1963.

First and second stage flight control switch-over parameters were submitted by Martin/SSD/Aerospace for defining switch-over criteria during slow drift malfunctions. Additional work is continuing to define the switch-over levels on each of the parameters.

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ATLAS/AGENA

TATIMITAT

Design

Design studies have been completed on the Agena multiple restart engine now designated as BAC No. 8247. The pressurized-start tank system has been selected for use with the Project GEMINI-Agenas. No serious problems have been reported on the development of the Agena Secondary Propulsion System (SPS) and its metal bellows propellant tanks.

The Agena status light and gage system has been removed from the GEMINI spacecraft and has been placed on the Agena docking adapter.

The latest Agena target vehicle weights and in-orbit velocity capabilities are reported as follows:

Agena cutoff weight in-orbit

_	J		
Les	s Stores:		
	Residuals	107	
	Agena 3 o Margin	125	
	Control Gas	97	
	SPS Propellants	336	
	Agena Impulse Propellants	3079	
	Propulsion Contingency	36	
	Helium	3	
Agei	na dry weight in-orbit		3268
Assı	med GEMINI spacecraft weight		6939
Velo	ocity capability		
	Predocked, single burn		5418 fps
	Postdocked, single burn		2340 fps

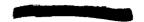


Budget Adjustments

Budget adjustment requirements for Project GEMINI have necessitated reprograming Atlas/Agena. Since October 25, 1962, considerable effort has been expended in the area of reprograming. Many areas of possible reduction were considered and evaluated. The following items are the essentials of the revised program:

- (1) The first Agena launch has been delayed four months.
- (2) An integrated approach to reliability and system testing has been pursued. Combining the reliability, development, and qualification tests has significantly reduced the overall test program without severe reduction of the reliability information obtained.
- (3) Developmental testing of the multiple start engine and Secondary Propulsion System has been reduced to minimum program requirements.
 - (4) The scope of the mission has not been changed.
- (5) Fiscal Year 1963 expenditures have been reduced by shortening production leadtime.
- (6) Consideration is being given to use of surplus Atlas boosters from Project MERCURY.

CONDITIONS



LAUNCH COMPLEX

Complex 19

Modifications to complex 19 began during the month of September 1962. Construction progress has been satisfactory with no major problems occurring. As of November 30, 1962, total construction modifications are 30 percent complete. Reprograming Project GEMINI funds did not affect complex 19 construction schedules and completion dates; however, AGE deliveries have been affected by the overall reprograming, thus resulting in a new complex activation completion date of August 1, 1963.

Activity highlights during this reporting period include the following items:

- (1) Study and implementation on man-rating of the Project GEMINI fire fighting systems for complex 19.
- (2) The feasibility of substituting a "blow vent stack" system in lieu of the vapor combustion system for Project GEMINI launch vehicles, and subsequent Atlantic Missile Range (AMR) Range Safety approval.
- (3) Development and implementation of a test procedure to load-test the erector.
- (4) Feasibility study of using the present capabilities of the erector as an astronaut emergency egress system.
- (5) Formation of a special Activations Installation Working Group to coordinate and resolve the difficulties of installation with the spacecraft cryogenics system.
- (6) Range Safety approval and decision on Project GEMINI launch vehicle AGE operation in a hydrogen atmosphere. Results are that all equipment operating below "four feet above the GLV Stage II fuel vent" on complex 19 will be required to fall within Class I, Electrical Code, Group D, NFC Specifications. At the present time, the Titan II R and D booster, and its complexes and associated AGE are configured and operating to this specification.

Complex 14

The preliminary design criteria review conference took place in Los Angeles, California on September 25, 1962. All contractors were represented and the A and E contractors, Maurice H. Connell and Associates, Inc., of Miami, Florida was introduced by the Space Systems Division/Aerospace.

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The meeting resulted in establishing the following ground rules which will be adhered to by all contractors in the preparation of their final criteria:

(1) Target Dates:

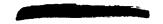
- (a) Stand availability July 1, 1963
- (b) Estimated Beneficial Occupancy Date November 1, 1963
- (c) Vehicle on Stand Date February 1, 1964

(2) Planned Users

- (a) Project GEMINI
- (b) Mariner Project
- (3) Prime consideration for basic modifications is to be given Project GEMINI with consideration also given to the Mariner Project in an effort to avoid "building-in" conflicts.
- (4) Criteria will be mailed to SSD with a copy sent simultaneously to the A and E contractor.
- (5) Establishment of a Complex 14 Activation Phasing Group similar to the one established on Complex 19.

The criteria review conference for complex 14 modifications was held at SSD, Los Angeles, California on November 15, 1962. The express purpose of this meeting was to review the Criteria Summary Report for complex 14 prepared by A and E contractor, Maurice H. Connell and Associates of Miami, Florida.

A complete review of the report by the affected contractors and Air Force agencies involved resulted in only minor engineering changes to the basic content of the report. These engineering changes were to be approved and incorporated into the Criteria Summary Report by December 1, 1962. At that time, a meeting will be held for the final acceptance and approval of the Criteria Summary Report.



NETWORK INTEGRATION

PROGRAM REQUIREMENTS DOCUMENT

A major effort was expended in this quarter to develop the Program Requirements Document (PRD). The PRD enables users of the National and Service Ranges to state their support requirements. With the support of Space Systems Division/Aerospace; George C. Marshall Space Flight Center; MSC - Flight Operations Division, - Operations Support Office, - Preflight Operations Division, and - Aerospace Medical Operations Officer; Goddard Space Flight Center; 6555th Aerospace Test Wing; Department of Defense; McDonnell Aircraft Corporation; and Air Force Missile Test Center; the GEMINI Project Office prepared a preliminary document which was published October 3, 1962. A PRD review meeting was held at MSC, Houston, Texas,October 30 and 31, 1962. As a result of the coordinated efforts of the above organizations, the GEMINI Project Office plans to release the final PRD for publication by December 10, 1962.

GROUND TRACKING NETWORK

During this quarter, the Goddard Space Flight Center issued contracts for the ground based Telemetry, Digital Command Encoding Equipment, R-F Command Equipment, and the Acquisition Aid Equipment. The above equipment includes the major ground tracking equipment which is required for installation at the remote sites. The currently proposed delivery schedules indicate that all equipment will be operational for the Project GEMINI flights.

TELEMETRY SYSTEMS

After the award of a contract to Electro-Mechanical Research Corporation to outfit the ground based telemetry stations, a PCM Working Group Meeting was held at MSC, Houston, November 20, 1962, with representatives from Space Systems Division/Aerospace, George C. Marshall Space Flight Center, Flight Operations Division and Preflight Operations Division of MSC, Goddard Space Flight Center, Lockheed Missiles and Space Company, and McDonnell Aircraft Corporation. The results of this meeting indicated that no major compatibility problems exist within the Project GEMINI telemetry systems.





DATA ACQUISITION PROCESSING PLAN

The GEMINI Project Office is currently developing a detailed data processing and analysis plan for Project GEMINI. Details for this plan will be formalized by March 1963, and will include inputs from all vehicle contractors plus cognizant elements of MSC.

GLV LAUNCH GUIDANCE GROUND COMPLEX

Interface requirements between the Goddard Space Flight Center command, tracking and computer facilities; Air Force Missile Test Center tracking and communications facilities; and the MSC computer and control facilities are being developed and interface specifications are being prepared with the support of the Flight Operations Division of MSC, Goddard Space Flight Center, and Space Systems Division/Aerospace. No major problems are obvious at this time.

COMMAND SYSTEM

The Goddard Space Flight Center awarded contracts for the Digital Command Encoding Equipment to Radiation, Inc. and the R-F Command Equipment to Collins Radio Company. Currently, the Flight Operations Division of MSC, Goddard Space Flight Center, and GEMINI Project Office are developing detailed plans for processing command messages from the computer facilities to the Mission Control Center and Integrated Mission Control Center (MCC and IMCC) and remote sites. Command loading studies for the Agena target vehicle have been developed by Lockheed Missiles and Space Company and have been submitted to the MSC for review. The ground based command system, as presently planned, will adequately satisfy the requirements for both the GEMINI spacecraft and the Agena target vehicle.

CREW TRAINING AND EQUIPMENT

TRAINING

An intensive training program began on October 15, 1962, for the flight crew personnel. In this reporting period, the "Flight Crew



Training Program" was published as NASA Working Paper No. 10,001 by the Flight Crew Operations Division. The working paper outlines the training program in some detail.

The primary training since October 15, 1962, has been projects familiarization and basic science study.

Projects Familiarization

The Project GEMINI familiarization has been accomplished at NASA facilities and contractor facilities. The familiarization has included briefings by personnel of the MSC, the Martin Company (Baltimore and Denver), the Aerojet-General Corporation, and the Lockheed Missile and Space Company. The familiarization will be completed with a visit to McDonnell Aircraft Corporation in the near future.

Classes

The basic science courses that are underway at this time are astronomy, rocket propulsion systems, flight mechanics, guidance and navigation, aerodynamics, and communications. A course in computers has been completed. The basic science program will also include courses in environmental control systems, physics of the upper atmosphere and space, medical aspects of spaceflight, selenology and global meteorology.

SIMULATORS AND TRAINERS

Mission Simulators

The schedule for the mission simulators has been revised. The first simulator will be delivered to Cape Canaveral in September 1963. The second will be ready for use at Houston in April 1964. The equations for the Link Digital Computer are scheduled to be complete in February 1963.

Breadboards of the Simulator Manual Data Insertion Unit, Digital Command Systems, and Voice Communications System have been built at McDonnell Aircraft Corporation. A review of the instructors' console was held at McDonnell Aircraft Corporation in September during which the layout of the panels was rearranged to make the controls more accessible. Block diagrams for the systems have been drawn and the design of the simulator system is progressing. The training mission may be completely preprogramed or the instructor may manually remove or insert additional failures through controls on the console. A series of simulator system briefings were given by McDonnell Aircraft





Corporation design engineers to MSC personnel during the coordination meetings in late November.

Centrifuge Trainer

Centrifuge trainer. The GEMINI centrifuge trainer is scheduled to be at the Johnsville Facility in May 1963. This trainer will be used to familiarize the new flight crew personnel with the GLV acceleration profile and allow the pilot's to evaluate the spacecraft displays and controls. The equations for the centrifuge training runs have been coordinated by the MSC, McDonnell Aircraft Corporation and Johnsville Facility. McDonnell Aircraft Corporation has purchased all the hardware items and is manufacturing the centrifuge gondola hardware. The design is approximately 85% complete and should be finished by early January 1963.

Docking and Translation Trainer

McDonnell Aircraft Corporation has the major portion of the docking and translation trainer design completed and its manufacture is approximately 50% complete. The air-bearing for this trainer is to be tested and checked in December so that trainer design can be finalized. The trainer should be complete and ready for set-up at McDonnell Aircraft Corporation in March 1963, with engineering tests starting in April and continuing until September 1963. These tests will provide the necessary inputs into the design of the latching and docking mechanisms prior to rendezvous missions. After September 1963, the trainer will be dismantled and sent to the MSC, Houston, where it will be set up and used for training the GEMINI flight crews.

Soft Mock-up

The soft mock-up was delivered to the MSC in early November 1962. This trainer is used for astronaut familiarization.

System Trainers

The system trainer designs were reviewed by the MSC-GEMINI Project Office system engineers. As a result of this review, one set of system trainers has been deleted. However, the requirement for this second set will be reviewed after the first set has been delivered and evaluated. The first trainers will be of the Spacecraft 2 configuration but will be maintained up-to-date as the design changes. Burtek and McDonnell Aircraft Corporation have coordinated the panel designs and Burtek is in the final stages of manufacture. Panels will be delivered to McDonnell Aircraft Corporation early next year for use in their training courses. The ejection seat trainer was delivered to McDonnell Aircraft





Corporation during September.

System Training Program

McDonnell Aircraft Corporation personnel have given one session of the classes on Project GEMINI system familiarization. Only two classes of each system will be held at McDonnell Aircraft Corporation; one with the system trainers. These classes will be over before 31 March 1963. The system trainers will then be shipped to the MSC. McDonnell Aircraft Corporation has submitted a training outline and transparencies for the propulsion system class to MSC for evaluation.

MISSION PLANNING

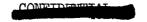
Mission planning and the supporting work in flight mechanics and guidance is being continued in bi-weekly meetings at the MSC which are:

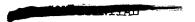
- (1) Trajectory and Orbits Panel
- (2) Launch Guidance Panel
- (3) Rendezvous and Reentry Guidance Panel
- (4) Mission Planning and Guidance Coordination Group

In addition to the contractor responsibilities covered in the last report, the Space Technology Laboratories contract is being renegotiated to add work in the terminal rendezvous and reentry phases of the Project GEMINI mission.

FLIGHT PLANNING

The first Project GEMINI flight will be a sub-orbital flight. Its main objective will be qualification of all hardware and systems required to permit the second and subsequent flights to be manned. The flight will be on an azimuth of 105 degrees with an impact range of approximately 1890 nautical miles. Specific trajectory parameters have been selected to provide a peak reentry heating rate and a high total heat to test the spacecraft heating protection. This trajectory also presents a complete test of the GLV and is acceptable from the standpoint of radar and telemetry coverage and recovery requirements.





The second, third and fourth flights are currently planned to be of one-, seven- and fourteen-days duration, respectively. Rendezvous experiments are being investigated for these flights using a small ejected pod to simulate the target vehicle. It is planned to simulate the rendezvous missions by using the same altitude and insertion conditions as the initial rendezvous orbits.

Although the first flight is handled separately, the other flights are being planned together. The rendezvous flights are the most restrictive and all procedures developed for the rendezvous flights will apply to the long duration flights (i.e., such as launch procedures).

ACCOMPLISHMENTS

Under the mission breakdown described in the last report, the following milestones have been reached in this reporting period.

- (1) <u>Launch-</u> Under the launch phase of the rendezvous missions, the following milestones were reached during the last three months.
- (a) Precise rendezvous orbits have been selected. The Agena target vehicle will be launched into a circular parking orbit of 161 nautical miles altitude with an inclination of 28.87 degrees. The GEMINI spacecraft will be launched approximately one day later on an azimuth of 81 to 98 degrees with an extended launch azimuth up to 105 degrees if necessary. Orbits required for launch of the spacecraft first are also being investigated and will be similar.
- (b) The spacecraft launch window has been optimized for four successive days following the Agena launch. The following launch windows have been determined:

First day	3.52 hours
Second day	4.36 hours
Third day	3.83 hours
Fourth day	4.65 hours

(c) Several booster guidance techniques have been considered and implementation of explicit guidance has been programed. It is planned to implement the explicit guidance as an option in the guidance equations such that implicit guidance may be selected by appropriate constants.

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- (d) In addition to the optimum launch window mentioned previously, other possible launch windows have been investigated. In the event of problems or changes in the program, these data would be available to determine a new optimum window for the changed conditions. (Changes could include development of more sophisticated recovery techniques, and added launch vehicle or target vehicle capabilities.)
- (e) Data have been generated on the optimum launch time for the two vehicles. Limitations include the requirement for daylight in the recovery area and the time of year for launch. Launch during darkness is not desirable and late afternoon launch would restrict performance of the GLV. The Agena launch time would be calculated from the desired spacecraft launch time. The only limitation on the Agena launch time is near sunrise where the rising sun would confuse the Agena horizon sensors.
- (f) The projected performance capability of the GLV indicates that the present spacecraft can be inserted into orbit with a high degree of probability; therefore, backup insertion capability at this time is not required based on present spacecraft weights and launch vehicle capability. However, study of the spacecraft backup insertion capability is being continued in the event of spacecraft weight growth or reduced launch vehicle capability. Range safety plans call for a three sigma probability of the empty GLV second stage impacting east of the African continent. Present planning requires the second stage to impact more than 600 nautical miles east of Madagascar. Between this minimum performance requirement for the GLV and the performance required for an acceptable initial insertion, investigation is being continued into using spacecraft propulsion (OAMS) to provide the necessary velocity difference. The approximate velocity requirement is 130 ft/sec with the exact requirement depending on the guidance and operating procedures used to add this velocity.
- (g) Several orbital ground tracks have been calculated and they show that a once-a-day primary landing capability will be provided and that some azimuths will permit landing on two or three consecutive orbits. The MSC is investigating specific fields to be implemented for Project GEMINI primary landing.

The work done for the launch phase will be reflected throughout the GEMINI mission planning. A large amount of data have been collected on the other phase and with the launch phase being near completion, the specific numbers can now be generated for the later phases of the mission. Alternate mission plans, such as launching the spacecraft first, are also being studied and the launch phase will form a basis for detailed analysis of these plans.

- (2) <u>Midcourse-</u> A large amount of data has been generated for the midcourse phase of the rendezvous missions and during the next reporting period, these data will be refined into limits and operational procedures. The Space Technology Laboratories' mission simulation program is being verified and will be producing significant results in the next reporting period.
- (3) Terminal and docking phases- Preliminary work as pertains to system hardware in the terminal and docking phases has been completed. Detailed hardware requirements have not been determined but are expected to have no effect on the basic hardware requirements (i.e., computer, guidance, attitude control) explained elsewhere in this report.
- (4) <u>Postrendezvous maneuvers</u>— Limits on postrendezvous maneuvers have been investigated and these investigations of detailed capabilities are being continued. Data have been generated on the performance limits associated with postrendezvous maneuvers and other limits such as possible radiation hazards which may be encountered.

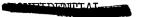
OPERATIONS, CHECKOUT AND AGE

PLANS

Plans for the preflight checkout of the GEMINI spacecraft remain as reported in the previous report. The facilities plan for implementation of this checkout, however, has been revised. The previously reported facilities plan defined Project GEMINI facilities as being wholly contained within the Hangar S - Hangar AF complex on Cape Canaveral. This is no longer true. Preflight checkout of the GEMINI spacecraft will be performed on Merritt Island where facilities will be provided for the use of Projects' GEMINI and APOLLO. Where practical, these facilities will be shared by both projects.

CHECKOUT LOCATIONS

Current schedule projections indicate that the first two GEMINI spacecraft will arrive at the Cape before the Merritt Island facilities are complete. For these spacecraft, therefore, master test stations will be installed on an interim basis in Hangar AF. Spacecraft Nos. 1 and 2, therefore, will be completely checked on the Cape except for any hypergolic, cryogen, and radar boresight checks that may be required. These checks are scheduled to be performed in facilities on



Merritt Island. Following Spacecraft No. 2 the entire preflight checkout operation will shift to Merritt Island. The Merritt Island facilities required by Project GEMINI are currently scheduled for completion during the first quarter of calendar year 1964.

RELIABILITY AND QUALITY ASSURANCE

During this reporting period, all of the major subcontractors for the spacecraft were visited. Reviews of the developmental test program, the qualification test program, and the reliability test program were conducted. The reliability test program is being revised as a result of these program reviews. Additional reviews are expected to be conducted during the next reporting period.

Quality assurance provisions for major subcontractors were revised and forwarded through procurement channels during the reporting period.

Approximately 80 percent of the government inspection agencies servicing the major system contractors were visited during the reporting period. The purpose of the visits was to clarify the NASA requirements and to assure the adequacy of the services rendered.

PROGRAM ANALYSIS AND REVIEW (PERT)

During this reporting period, budgetary limitations forced a change in the Project GEMINI launch schedule and a slight modification of program content, although the program goals and missions were not materially affected. The project planning details are being revised to implement these changes, and are being reflected in the PERT charts as well as other Project GEMINI planning data.

Several months' experience has been obtained with the PERT applications on some areas of Project GEMINI. Therefore, the various PERT applications are being reviewed to determine the optimum use of the PERT technique. This review may result in a reduction of PERT requirements in some areas and an increase in others.

The FERT reporting on the GEMINI spacecraft and Titan II launch vehicle and associated facility effort has continued as described in the previous report. A simplified FERT-type reporting system for the Atlas-Agena portion of the project has also been implemented, and biweekly updating is received from the Marshall Space Flight Center.



For the Lockheed Missiles and Space Company effort, a single PERT-type network depicts approximately 175 key program milestones with their scheduled completion dates. The logical constraints between various milestones are shown. Lockheed Missiles and Space Company reports status against and changes to the network biweekly to George C. Marshall Space Flight Center who reviews and transmits the Lockheed Missiles and Space Company status report to the MSC together with a status report on the Atlas deliveries and the overall Project GEMINI Atlas-Agena program.

Implementation of PERT on Phase IIb(1) of the paraglider program has commenced. Initial PERT networks have been received from North American Aviation; and review, modification, and coordination of the information is underway. Biweekly PERT data status reports will be received from North American Aviation on alternate Fridays. This will be followed by transmission of a management analysis of the PERT data which will be received by MSC on Tuesday following the Friday input. The analysis will include a description of the problem areas, management action to be taken or being considered, and an estimate of the results of the corrective actions.

Project Gemini — Launch program —

